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General Certificate of Secondary Education
June 2006



**CHEMISTRY (SPECIFICATION B)
Foundation Tier**

3421/F
F

Wednesday 14 June 2006 9.00 am to 11.15 am

| |
|---|
| <p>For this paper you must have:</p> <ul style="list-style-type: none"> • a ruler • the Data Sheet (enclosed) <p>You may use a calculator.</p> |
|---|

Time allowed: 2 hours 15 minutes

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.

Information

- The maximum mark for this paper is 135.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

| For Examiner's Use | | | |
|---------------------|------|--------|------|
| Number | Mark | Number | Mark |
| 1 | | 14 | |
| 2 | | 15 | |
| 3 | | 16 | |
| 4 | | 17 | |
| 5 | | 18 | |
| 6 | | 19 | |
| 7 | | 20 | |
| 8 | | 21 | |
| 9 | | 22 | |
| 10 | | 23 | |
| 11 | | | |
| 12 | | | |
| 13 | | | |
| Total (Column 1) → | | | |
| Total (Column 2) → | | | |
| TOTAL | | | |
| Examiner's Initials | | | |

Answer **all** questions in the spaces provided.

- 1 (a) A small piece of sodium is added to water.

The table shows some statements.

Only four of these describe what happens when sodium reacts with water.

One of these has been ticked for you.

Put a tick (✓) next to the other **three**.

| | |
|--|---|
| Sodium hydroxide solution is produced | ✓ |
| Sodium fizzes | |
| Sodium sinks to the bottom of the water | |
| Sodium moves around | |
| Sodium reacts to form an acidic solution | |
| Sodium sometimes melts | |
| Bubbles of oxygen gas are produced | |

(3 marks)

(b) Sodium hydroxide solution is sometimes made by adding a mixture of mercury and sodium to water. The mercury does **not** react.

(i) What does this suggest about the position of mercury, if you were to place it in the reactivity series of metals?

.....
(1 mark)

(ii) Mercury is toxic.

Which hazard symbol, **A**, **B**, **C** or **D**, should be used to warn people of this danger?



The hazard symbol for toxic is
(1 mark)

(c) A salt is produced when sodium hydroxide reacts with nitric acid.

Choose **two** substances from the box to complete the word equation for this reaction.

| | | | |
|-----------------|----------------|-----------------|-------|
| sodium chloride | sodium nitrate | sodium sulphate | water |
|-----------------|----------------|-----------------|-------|

Sodium hydroxide + nitric acid → +
(2 marks)

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| 7 |
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Turn over for the next question

Turn over ►

2 The periodic table on the Data Sheet may help you to answer this question.

The diagram shows an outline of the periodic table.

| | | | | | | | | | | | | | | | | | | | |
|----------|----------|--|--|--|--|--|----------|--|--|--|--|--|--|--|--|--|--|--|--|
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| A | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | E | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | F | | | | | | | | | | | | | | | | | | |
| G | | | | | | | | | | | | | | | | | | | |

Choose your answers **only** from the letters shown on this outline table.

Which letter, **A** to **G**, represents an element that:

(a) is a non-metal;

Letter
(1 mark)

(b) is a group 2 element;

Letter
(1 mark)

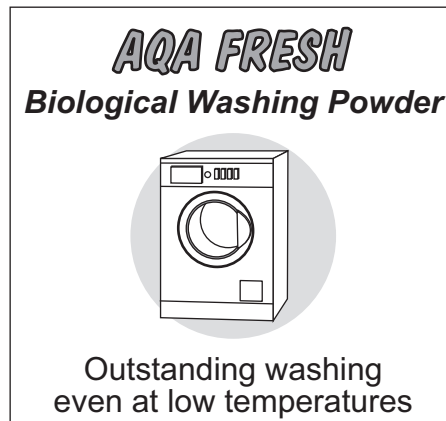
(c) has 19 protons in the nucleus of its atoms;

Letter
(1 mark)

(d) is a transition element?

Letter
(1 mark)

3 Biological washing powders contain biological catalysts.



(a) (i) How does a catalyst help a chemical reaction?

.....
(1 mark)

(ii) Complete this sentence by choosing the correct word from the box.

| | | | |
|--------------|----------------------|----------------|---------------------|
| bases | carbohydrates | enzymes | hydrocarbons |
|--------------|----------------------|----------------|---------------------|

Biological catalysts are called

(1 mark)

(b) Biological catalysts help to remove stains from clothes.
Four types of biological catalyst are given in the box.

| | | | |
|----------------------|-------------------|----------------|------------------|
| carbohydrases | isomerases | lipases | proteases |
|----------------------|-------------------|----------------|------------------|

Choose **two** biological catalysts from the box to complete the table.

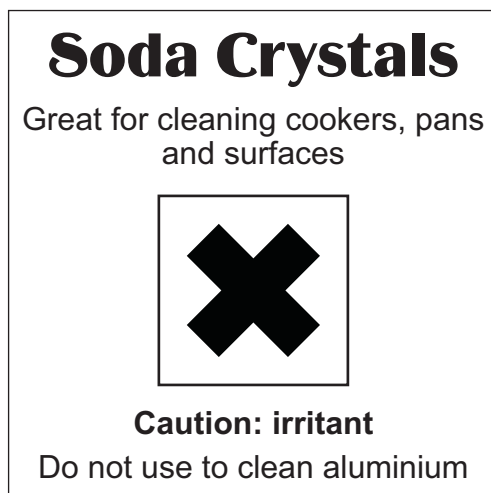
| Name of biological catalyst | Type of stain which it helps to remove |
|-----------------------------|--|
| | Stains caused by fats |
| | Stains caused by proteins |

(2 marks)

(c) Suggest **one** advantage of using a washing powder containing biological catalysts.

.....
.....
(1 mark)

4 This label was on a packet of soda crystals.



- (a) Soda crystals are an irritant.
- (i) The list gives some of the ways in which substances can be hazardous.

Put a tick (✓) next to the **two** ways in which irritant substances can be hazardous.

| Hazard | (✓) |
|--|-----|
| Attack and destroy living tissue | |
| Blistering of the skin | |
| Catch fire easily | |
| Make other substances burn more fiercely | |
| Reddening of the skin | |

(2 marks)

- (ii) Suggest an item of safety equipment that should be worn when using a solution of soda crystals.

.....
(1 mark)

- (b) Soda crystals dissolve in water to form an alkaline solution.

Which **one** of the following ions makes the solution alkaline?

Draw a ring around your answer.

ammonium **hydrogen** **hydroxide** **sodium**

(1 mark)

(c) A reaction takes place when a warm soda solution is added to aluminium.

A word equation can be used to describe this reaction.

soda + aluminium → sodium aluminate + sodium hydrogencarbonate + hydrogen
 solution solid solution solution gas

(i) An aluminium saucepan should **not** be cleaned with soda solution. Explain why.

.....

(1 mark)

(ii) A sample of the gas produced was collected in a test tube.

How could you show that the gas is hydrogen?

The test you would do:

.....

The result of the test:

.....

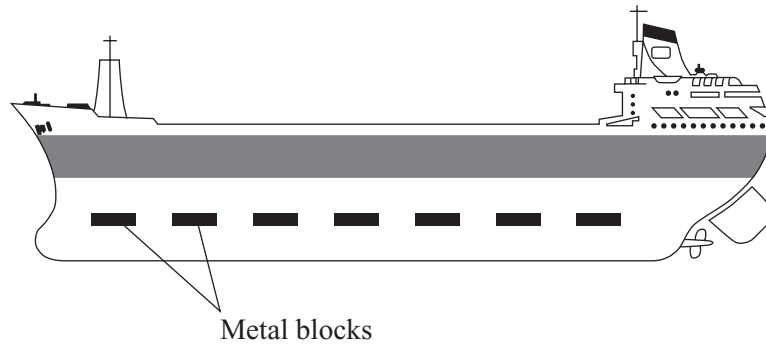
(2 marks)

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Turn over for the next question

Turn over ►

- 5 (a) A ship's hull is made from iron.
Blocks of another metal are attached to the hull to prevent the iron from rusting.



The reactivity series on the Data Sheet may help you to answer this question.

- (i) Which **two** metals in the table could be used to prevent the iron hull from rusting?

Put a tick (✓) next to each of these metals.

| Name of metal | (✓) |
|---------------|-----|
| Copper | |
| Gold | |
| Magnesium | |
| Platinum | |
| Silver | |
| Zinc | |

(2 marks)

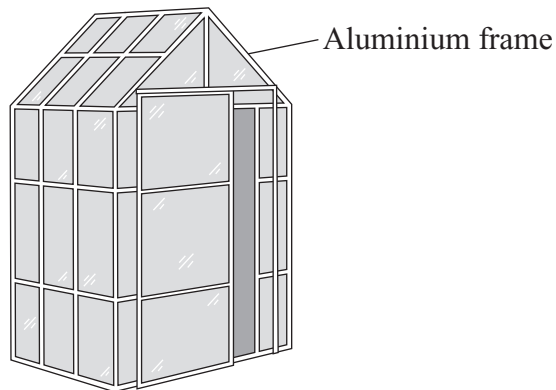
- (ii) What will happen to these blocks of metal after they have been attached to the hull for some time?

.....

.....

(1 mark)

- (b) The frames of greenhouses are often made from aluminium. Although they are not painted, they last for many years.



- (i) Why might aluminium be expected to corrode more easily than iron?

.....
(1 mark)

- (ii) Use the words in the box to complete the following sentences.

| | | | | |
|-----|----------|----------|-------|-------|
| air | chloride | nitrogen | oxide | water |
|-----|----------|----------|-------|-------|

A thin layer of aluminium forms on the surface of the aluminium. This keeps out and which are the substances that cause corrosion.

(3 marks)

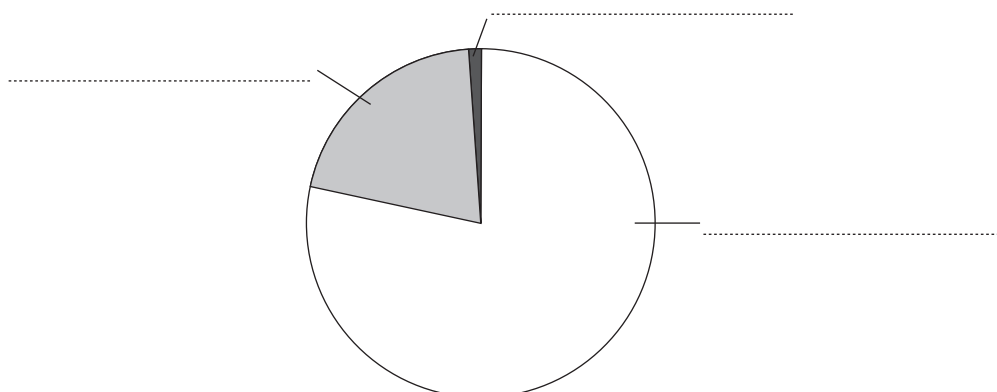
| |
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Turn over for the next question

Turn over ►

- 6 (a) The three main gases in the air are argon, nitrogen and oxygen.

Label the pie chart below to show the percentage by volume of each gas in the air.



(1 mark)

- (b) The gases in air have many uses.

Draw a line from each use to one of the gases. One of the gases has two uses.

Use of gas

Used to change ammonia
into nitric acid

An inert gas used to fill
filament lamps

The pure gas is used to
make substances burn fiercely

Used to make ammonia

Gas

Argon

Nitrogen

Oxygen

(4 marks)

7 Dalton stated that the atoms of each element were different from the atoms of every other element.

(a) The table gives information about the atoms of two elements, helium and lithium.

| | Helium | Lithium |
|---|--------|---------|
| Atomic number (proton number) | 2 | 3 |
| Mass number (mass number = number of protons + number of neutrons) | 4 | 7 |

Use this information to help you to complete the sentences.

This helium atom is different from this lithium atom because:

- the helium atom contains protons while the lithium atom contains protons;
- the helium atom contains neutrons while the lithium atom contains neutrons.

(3 marks)

(b) (i) The properties of an element depend on how the electrons are arranged in its atoms.

Diagram 1 shows the electronic structure of a helium atom which has 2 electrons. Complete **Diagram 2** to show the electronic structure of a lithium atom.

Diagram 1

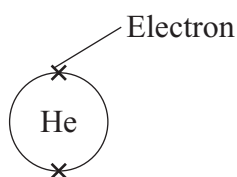
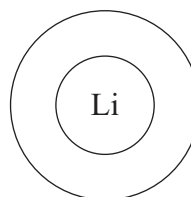


Diagram 2



(1 mark)

(ii) The periodic table on the Data Sheet may help you to answer this question. Complete this sentence by choosing the correct element from the box.

| | | | |
|--------|--------|---------|--------|
| copper | iodine | silicon | sodium |
|--------|--------|---------|--------|

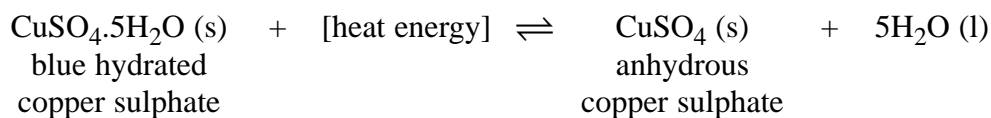
The element which is most similar to lithium is

(1 mark)

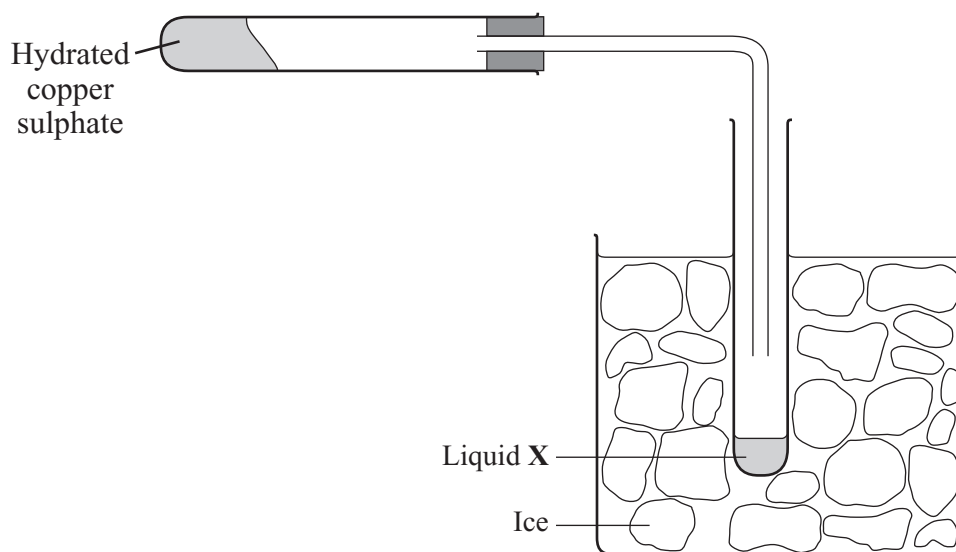
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Turn over ►

8 A student investigated the reaction represented by this equation.



The diagram shows the apparatus that the student used.



- (a) (i) What must the student do to the hydrated copper sulphate to make the reaction take place?

.....
(1 mark)

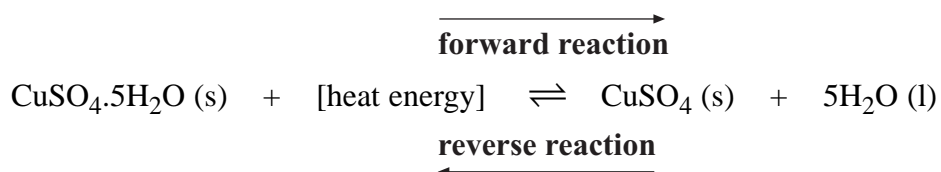
- (ii) Name liquid X.
(1 mark)

- (iii) Complete this sentence by choosing the correct word from the box.

| | | | |
|-------------|--------------|------------|--------------|
| blue | green | red | white |
|-------------|--------------|------------|--------------|

The colour of anhydrous copper sulphate is
(1 mark)

- (b) This is an example of a reversible reaction.



- (i) Describe how the **reverse** reaction can be used as a test for water.

.....

.....

.....

.....

(2 marks)

- (ii) The **forward** reaction is endothermic.

Complete the sentence below by crossing out the **two** answers that are wrong.

In the **reverse** reaction the temperature of the mixture will

| | |
|---------------|---|
| increase | . |
| stay the same | |
| decrease | |

(1 mark)

| |
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Turn over for the next question

Turn over ►

- 9 (a) Complete each sentence about the manufacture of steel by choosing the correct substances from the box.

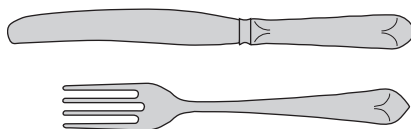
| | |
|--------------------------|------------------------|
| calcium carbonate | sodium chloride |
| carbon | nitrogen |
| | oxygen |

Molten iron from the blast furnace is mixed with recycled scrap iron.

Pure gas is passed into the mixture. This converts the non-metal impurities into acidic oxides. Then is added to remove these acidic oxides. Calculated quantities of and other elements are then added to make steels with particular properties.

(3 marks)

- (b) Stainless steel is used to make cutlery.



Some properties are given in the table below.

Three of these are properties that make stainless steel a good material for cutlery.

One of these properties has been ticked for you. Place a tick (✓) next to the other **two** properties.

| Property | Tick (✓) |
|----------------------|-----------------|
| Conducts electricity | |
| Breaks easily | |
| Hard | |
| Resists corrosion | |
| Toxic | |
| Unreactive | ✓ |

(2 marks)

| |
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10 Chemical tests are used to identify compounds.

- (a) Which **one** of the following is the colour of sodium compounds in flame tests?

Draw a ring around your answer.

blue **green** **red** **yellow**

(1 mark)

- (b) Complete this sentence by crossing out the names of the **two** gases in the box that are wrong.

Carbonates react with dilute acids to form

| |
|----------------|
| carbon dioxide |
| chlorine |
| oxygen |

(1 mark)

- (c) Chemical tests are carried out on some substances.

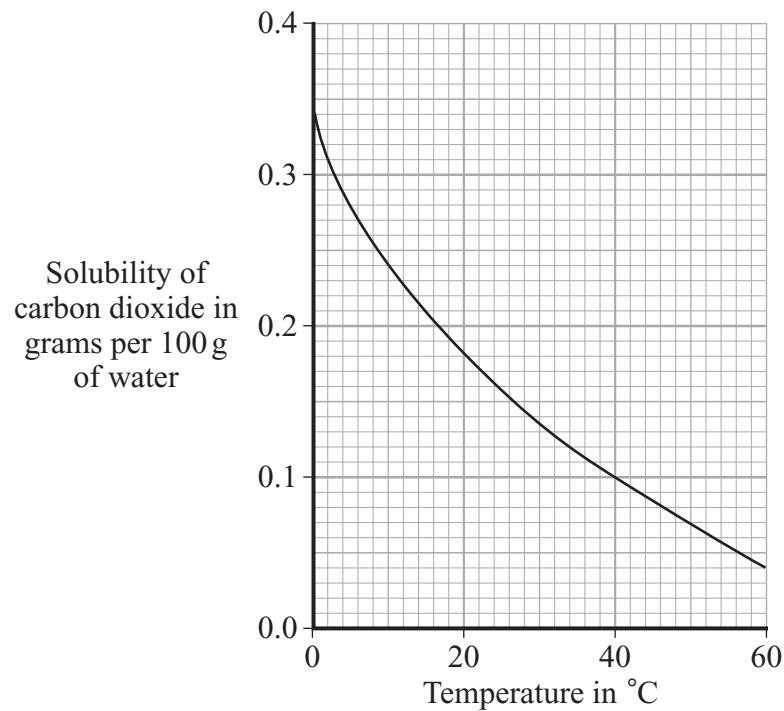
| | | |
|--------------------------|--------------------------|---------------------------|
| ammonium nitrate | iron(III) nitrate | magnesium chloride |
| potassium bromide | zinc carbonate | |

Complete each sentence by choosing the correct substance from the box.

- (i) A solution containing reacts with sodium hydroxide solution to form a rust-brown precipitate. (1 mark)
- (ii) A solution containing reacts with silver nitrate solution, in the presence of dilute nitric acid, to form a white precipitate. (1 mark)
- (iii) On heating, forms a yellow solid that goes white on cooling. (1 mark)
- (d) State what you **see** when sodium sulphate solution reacts with barium chloride solution in the presence of dilute hydrochloric acid.

..... (1 mark)

- 11 The graph shows the solubility of carbon dioxide. The solubility is the mass of carbon dioxide that dissolves in 100 g of water at different temperatures.



- (a) Use the graph to answer the following questions.

- (i) What happens to the solubility of carbon dioxide as the temperature increases?

.....
(1 mark)

- (ii) What mass of carbon dioxide dissolves in 100 g of water at 10°C?

Mass = g
(1 mark)

- (iii) What mass of carbon dioxide gas comes out of 100 g of water when the temperature increases from 10°C to 50°C?

.....
.....

Mass = g
(2 marks)

- (b) Pressure can also affect the mass of carbon dioxide that will dissolve in water. Which row in the table shows the conditions for dissolving the largest mass of carbon dioxide in 100 g of water?

Place a tick (✓) next to the correct conditions.

| Conditions | | Tick (✓) |
|------------|-------------|----------|
| Pressure | Temperature | |
| low | low | |
| low | high | |
| high | low | |
| high | high | |

(1 mark)

| |
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Turn over for the next question

Turn over ►

12 Read the passage about carbon monoxide.

CARBON MONOXIDE: THE SILENT KILLER

Carbon monoxide is a very poisonous gas. It has no smell, taste or colour.

Carbon monoxide is formed by the incomplete combustion of fossil fuels. These fuels are used in boilers, engines, gas fires, water heaters and open fires.

Deadly carbon monoxide is formed when rooms are poorly ventilated or the chimney is blocked.

It is very important to have:

- good ventilation and not block air vents;
- appliances checked each year;
- chimneys checked regularly;
- a reliable detector alarm.

Use the information in the passage and your knowledge of chemistry to answer these questions.

(a) Carbon monoxide is a poisonous gas.

State **another** word, from the passage, which tells you that this gas is poisonous.

.....
(1 mark)

(b) Give **one** reason, mentioned in the passage, why people do not realise that they are breathing in carbon monoxide.

.....
(1 mark)

(c) Complete this sentence.

Incomplete combustion occurs when there is not enough
(1 mark)

- (d) Coal and crude oil are fossil fuels.

Which **one** of the following is also a fossil fuel?

Draw a ring around your answer.

bauxite

iron ore

limestone

natural gas

(1 mark)

- (e) Complete this sentence by crossing out the **two** words in the box that are wrong.

Carbon monoxide is poisonous because it reduces the capacity of the blood to

carry

| |
|----------|
| nitrogen |
| oxygen |
| water |

.

(1 mark)

| |
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Turn over for the next question

Turn over ►

- 13 (a) Complete the sentences about the extraction of titanium.

Choose the correct words from the box.

| | | |
|--------|---------|--------|
| argon | bauxite | copper |
| oxygen | rutile | sodium |

Titanium is extracted from an ore called which contains titanium dioxide.

Titanium dioxide is converted into titanium chloride.

Titanium chloride is reacted with the alkali metal to form titanium.

This reaction is carried out in an atmosphere of the noble gas
(3 marks)

- (b) Other metals are added to titanium to make alloys.

The table shows the percentage (%) of other metals in some titanium alloys.

| Titanium Alloy | Other metals (%) | | | | | |
|----------------|------------------|----|----|----|----|----|
| | Al | Fe | Mo | Sn | V | Zr |
| Alloy A | 3 | 2 | – | – | 10 | – |
| Alloy B | 3 | 2 | 8 | – | 8 | – |
| Alloy C | 6 | – | 6 | 2 | – | 4 |
| Alloy D | 6 | – | 2 | 2 | – | 4 |

Which alloy contains the highest percentage of titanium?
(1 mark)

- (c) Give **one** use of titanium or titanium alloys.

.....
(1 mark)

14 Read the information about plastic-tar and then answer the questions.

Plastic-Tar Roads!

A town in India has made a road from plastic-tar. The town mayor is quoted as saying, ‘using plastic-tar will reduce the problem of plastic waste’.

Roads are usually made from a mixture of bitumen and gravel. Plastic-tar is made by mixing the bitumen and gravel with plastic. This plastic is obtained from household waste material.

Plastic-tar is harder and more waterproof than ordinary tar. This helps it to last longer.

- (a) Use your knowledge of plastics to explain why the disposal of plastic waste is difficult, making it a problem for the environment.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....
.....
.....
.....
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(4 marks)

- (b) Suggest **two** advantages of using waste plastic to make plastic-tar.

.....
.....
.....
.....

(2 marks)

6

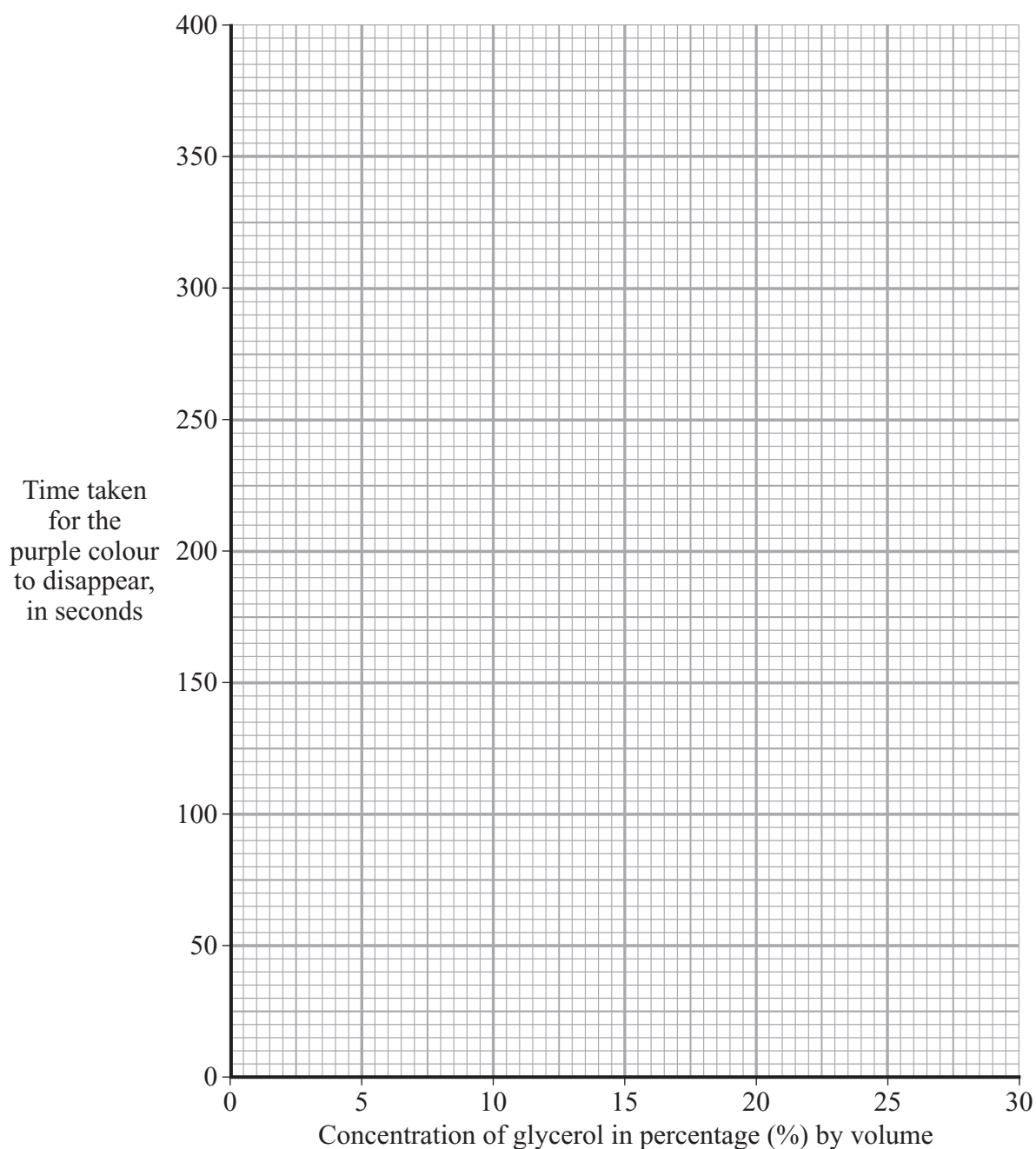
Turn over ►

- 15 Glycerol reacts with a purple solution to form colourless products. The time taken for the purple colour to disappear can be used to measure the rate of this reaction.

A student did some experiments to find out how the concentration of glycerol affects the rate of this reaction. The results are shown in the table.

| | | | | | |
|---|-----|-----|----|----|----|
| Concentration of glycerol in percentage (%) by volume | 4 | 10 | 16 | 24 | 30 |
| Time taken for the purple colour to disappear, in seconds | 375 | 150 | 94 | 63 | 50 |

- (a) Plot these points on the graph and draw a smooth curve through the points.



(3 marks)

(b) The time taken for the purple colour to disappear when the concentration of the glycerol is 10 % is 150 seconds.

(i) Use your graph to estimate the time it would take for the purple colour to disappear when the concentration of glycerol is 20 %.

Time = seconds
(1 mark)

(ii) If the concentration of glycerol is doubled, what happens to the **rate** of reaction?

.....
.....
(1 mark)

(iii) Explain, in terms of particles, why increasing the concentration of glycerol increases the rate of this reaction.

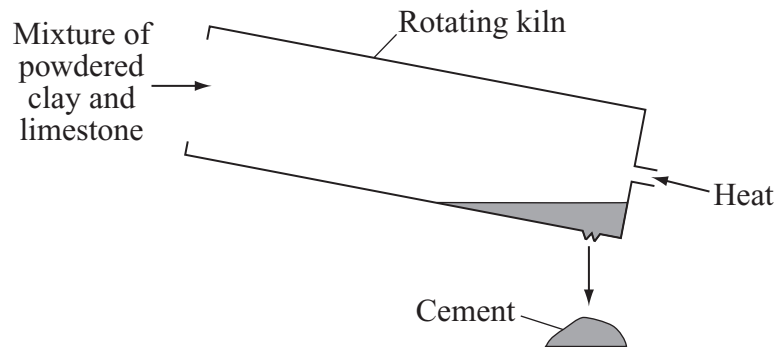
.....
.....
.....
.....
(2 marks)

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Turn over for the next question

Turn over ►

16 (a) Limestone is an important raw material in the manufacture of cement.



In this process:

- powdered limestone and clay are mixed in a rotating kiln;
- *thermal decomposition* of the limestone takes place to produce calcium oxide;
- the calcium oxide then reacts with the clay to make cement.

(i) Explain what is meant by the term *thermal decomposition*.

.....

 (2 marks)

(ii) Thermal decomposition of calcium carbonate also produces a gas which turns limewater milky.

Name this gas. (1 mark)

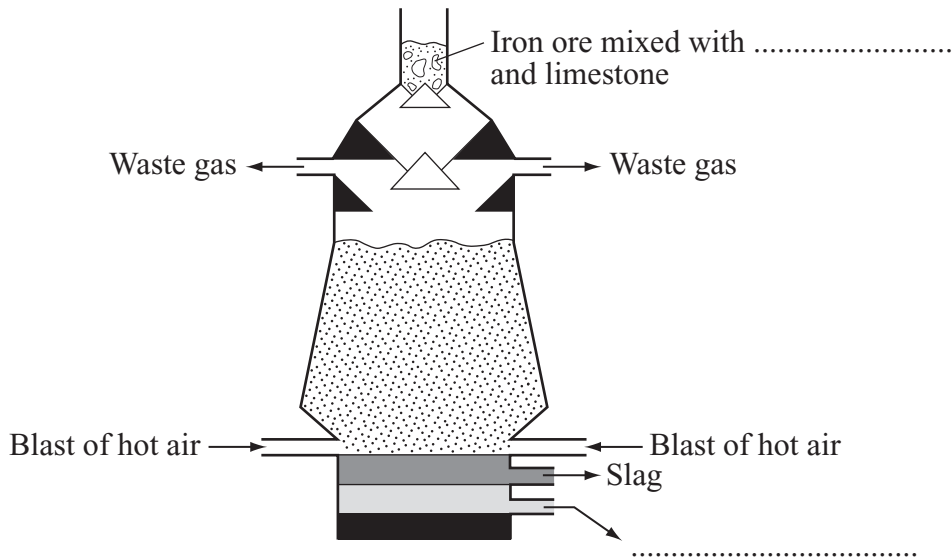
(iii) Suggest why a rotating kiln is used.

.....
 (1 mark)

(b) Limestone is also used in the extraction of iron in the blast furnace.

The diagram shows a blast furnace.

(i) Complete the diagram by adding the **two** missing labels.



(2 marks)

(ii) The iron ore (iron oxide) is *reduced* in the furnace.

Explain what is meant by the term *reduced*.

.....
.....

(1 mark)

(iii) The slag obtained from the blast furnace can be ground up and used to make a type of cement.

This is different from the method described in part (a) of this question.

Suggest and explain **one** advantage of using blast furnace slag to make cement.

.....
.....
.....
.....

(2 marks)

17 Iron(II) sulphate tablets are used to treat people with iron deficiency.

This label was on a bottle of tablets.

Iron(II) sulphate tablets

FeSO₄

100 iron(II) sulphate tablets.
Each tablet contains 0.2 g of FeSO₄

(a) Calculate the relative formula mass (M_r) of iron(II) sulphate, FeSO₄.

Relative atomic masses: O = 16; S = 32; Fe = 56.

.....
.....

Relative formula mass =
(2 marks)

(b) Calculate the percentage by mass of iron in iron(II) sulphate.

.....
.....

Percentage by mass of iron = %
(2 marks)

(c) The 100 iron tablets in the bottle contain a total mass of 20 g of iron(II) sulphate.

Calculate the mass of iron in 20 g of iron(II) sulphate.

.....
.....

Mass of iron = g
(2 marks)

| |
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18 The periodic table on the Data Sheet may help you to answer this question.

The diagram shows a Group in a periodic table designed by John Newlands in 1864. The Group contains elements found in Group 7 (the halogens) of the modern periodic table (fluorine, chlorine, bromine and iodine) and other elements.

| |
|--------------|
| H |
| F |
| Cl |
| Co/Ni |
| Br |
| Pd |
| I |
| Pt/Ir |

(a) Cobalt, nickel, palladium, platinum and iridium are now classed as transition elements. State **three** ways in which the properties of transition elements are different from halogens.

- 1
- 2
- 3
- (3 marks)*

(b) Hydrogen is difficult to place in the modern periodic table.

(i) Use the table of ions on the Data Sheet to help you to give **one** way in which hydrogen is similar to the elements in Group 1.

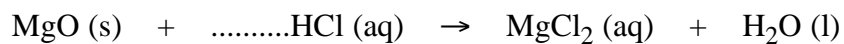
-
-
- (1 mark)*

(ii) Give **one** property of hydrogen which makes it similar to the elements at the top of Group 7.

-
-
- (1 mark)*

19 (a) A solution of magnesium chloride can be made by reacting magnesium oxide with **warm** hydrochloric acid.

(i) Balance the equation for this reaction.



(1 mark)

(ii) Describe how you would make a solution of magnesium chloride starting with magnesium oxide powder and hydrochloric acid.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

.....

.....

.....

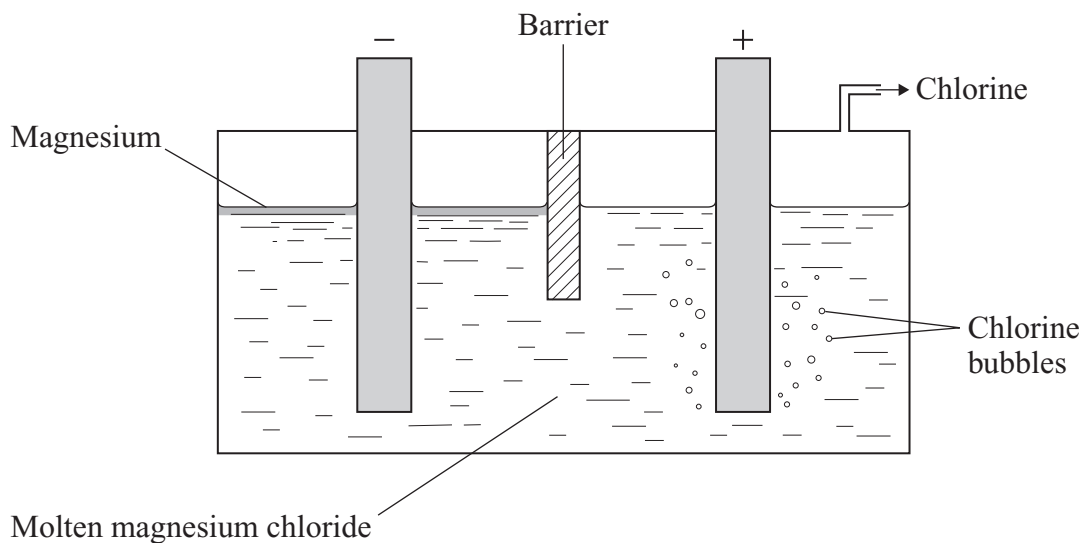
.....

.....

.....

(5 marks)

- (b) Magnesium and chlorine can be made by the electrolysis of molten magnesium chloride.



- (i) Magnesium is formed at the negative electrode.

Explain why.

.....

.....

.....

.....

(2 marks)

- (ii) Chlorine is often added to drinking water.

Explain why.

.....

.....

(1 mark)

| |
|---|
| 9 |
|---|

Turn over ►

20 (a) (i) Describe how to make a dilute solution of ethanol from sugar by fermentation.

*To gain full marks in this question you should write your ideas in good English.
Put them into a sensible order and use the correct scientific words.*

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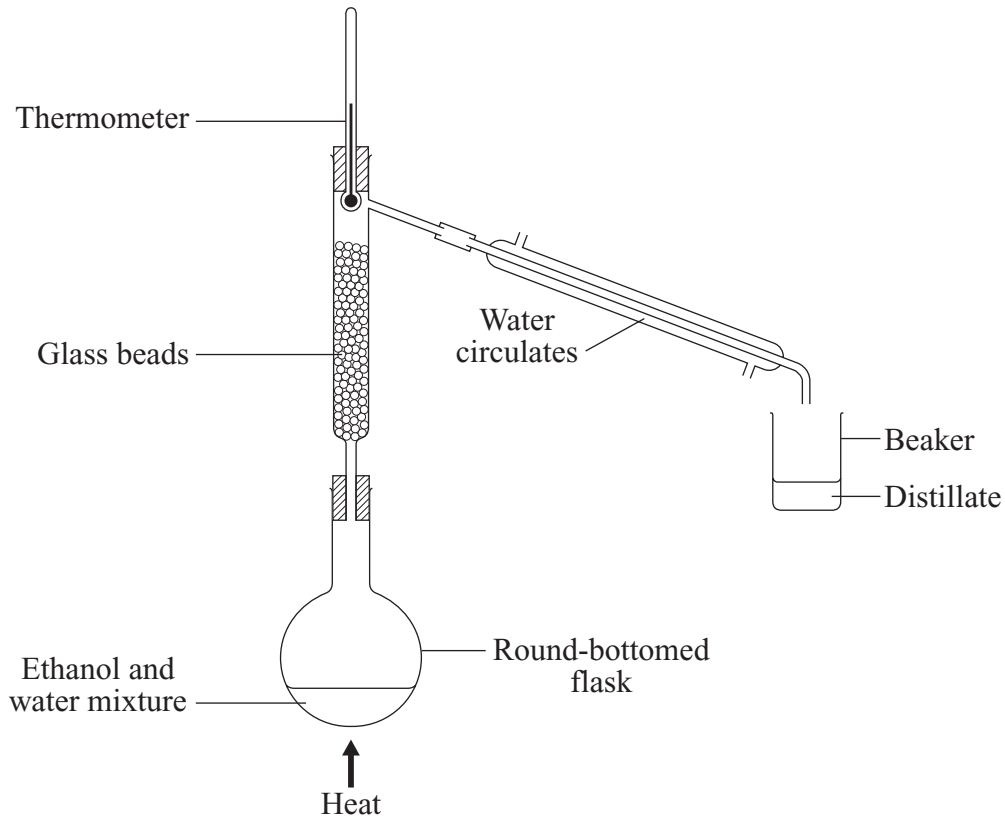
(5 marks)

(ii) Name the gas which is produced by fermentation.

.....

(1 mark)

- (b) The diagram shows how ethanol (boiling point 78°C) can be separated from water (boiling point 100°C).



- (i) Name this type of distillation.

.....
(1 mark)

- (ii) Which liquid, ethanol or water, will be the first to distil over into the beaker?


.....

Give a reason for your answer.

.....
(1 mark)

21 These labels are from two bottles of spring water.

| Still | |
|-------------------------|---------------------------------|
| Alice's Spring | |
| Australian Spring Water | |
| Ions present | Concentration (mg per litre) |
| chloride | 20.0 |
| sodium | 14.0 |
| magnesium | 5.0 |
| calcium | 3.0 |
| hydrogencarbonate | 2.0 |
| potassium | 1.0 |

| SOURCE | |
|--|---------------------------------|
|  | |
| Still Natural Mineral Water | |
| Ions present | Concentration (mg per litre) |
| chloride | 5.0 |
| calcium | 4.5 |
| sulphate | 4.0 |
| sodium | 3.0 |
| nitrate | 1.9 |
| magnesium | 1.3 |
| potassium | 0.5 |

(a) (i) Suggest why the amounts of sodium ions in these spring waters are different.

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(2 marks)

(ii) 'Alice's Spring' water is harder than 'Source' water.

Use the information on the label to explain why.

.....

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(1 mark)

(iii) Describe and give the result of a test to show that these spring waters are hard.

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(2 marks)

(b) Explain how sodium carbonate softens hard water.

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(2 marks)

(c) State **one** advantage of hard water.

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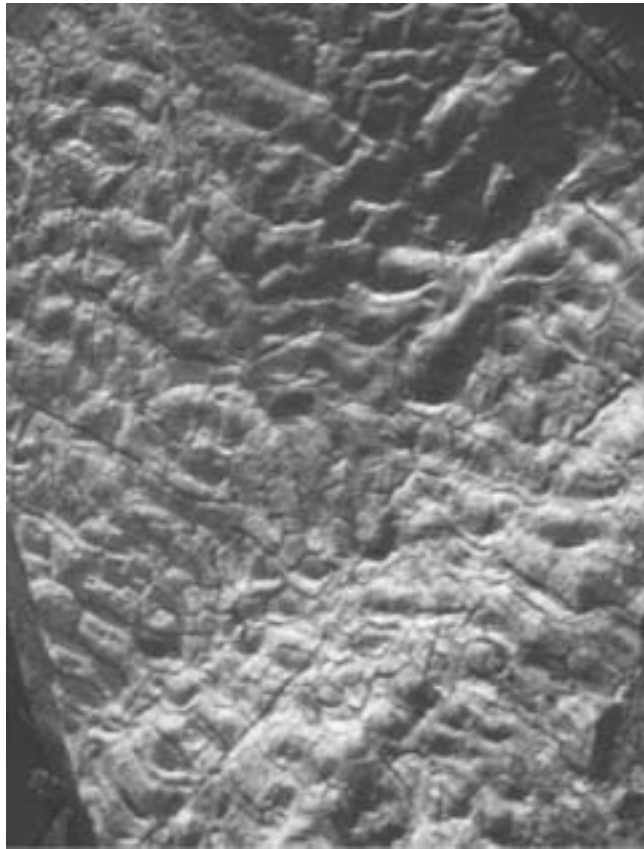
(1 mark)

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| |
| 8 |

Turn over for the next question

Turn over ►

22 The picture shows ripple marks on rock found in Dorset.



These ripple marks were formed when the sediments were first laid down.

Explain how these ripple marks could have been formed.

.....

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.....

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(2 marks)

| |
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| 2 |

23 Arrhenius in 1884, and Brønsted and Lowry in 1923, put forward ideas that explained acid-base behaviour.

- (a) Hydrochloric acid, HCl, behaves as an acid when it reacts with sodium hydroxide, NaOH.

Explain why, using the ideas of Arrhenius.

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(2 marks)

- (b) The work of Arrhenius took much longer to be accepted than the work of Brønsted and Lowry.

Suggest a reason why.

.....
.....

(1 mark)

| |
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| |
| 3 |

END OF QUESTIONS

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